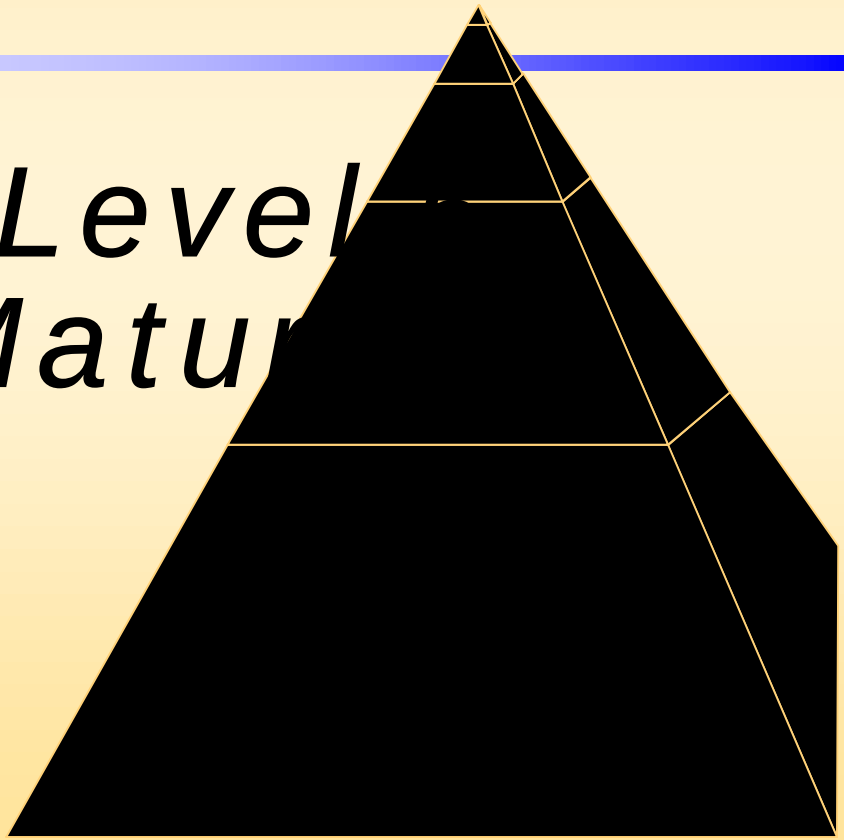
24th Annual Software Engineering Workshop

Attaining Level
Process Matu



Frank McGarry
Bill Decker
Joe Haskell
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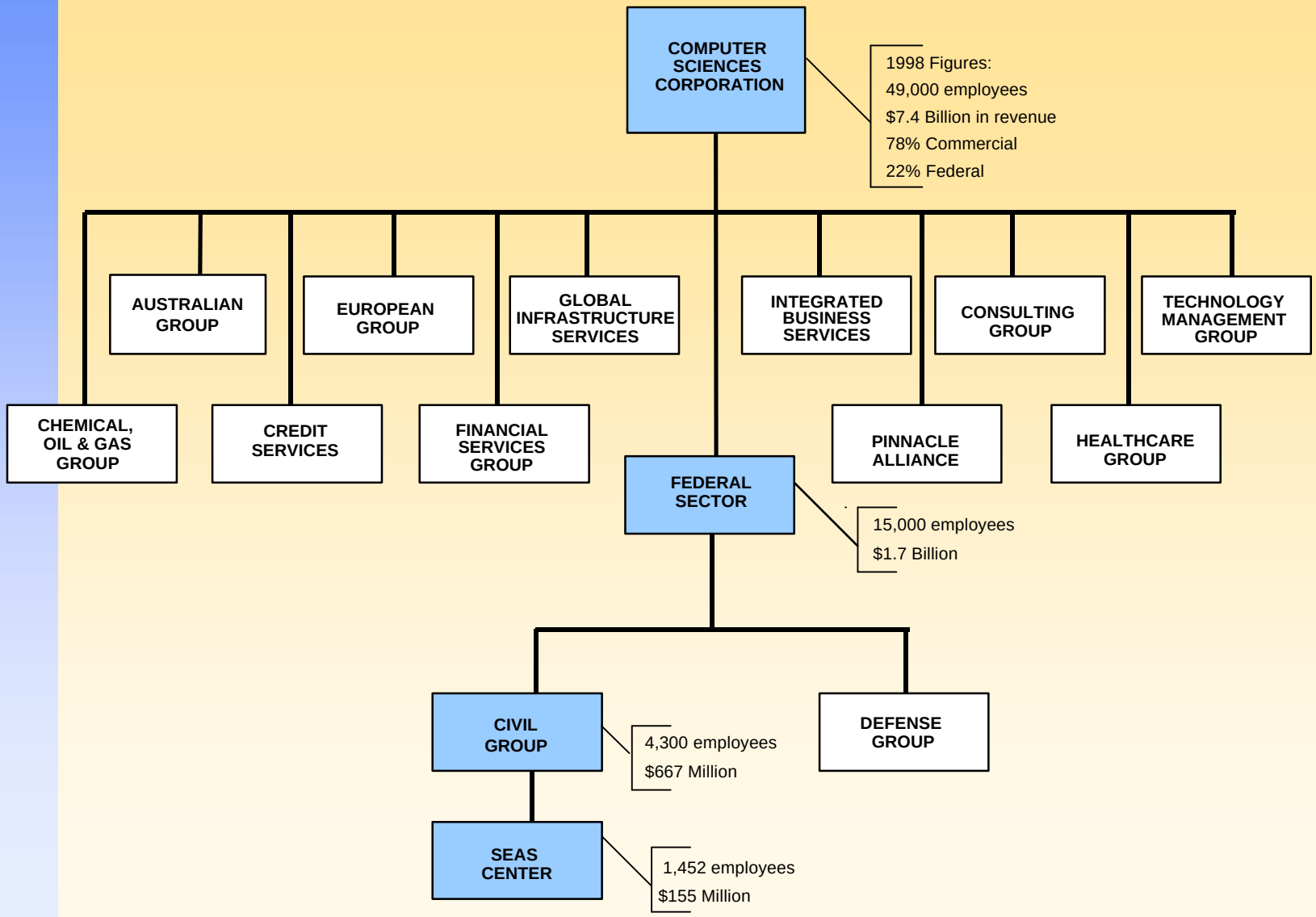
Computer Sciences Corporation

SEAS Center Within CSC



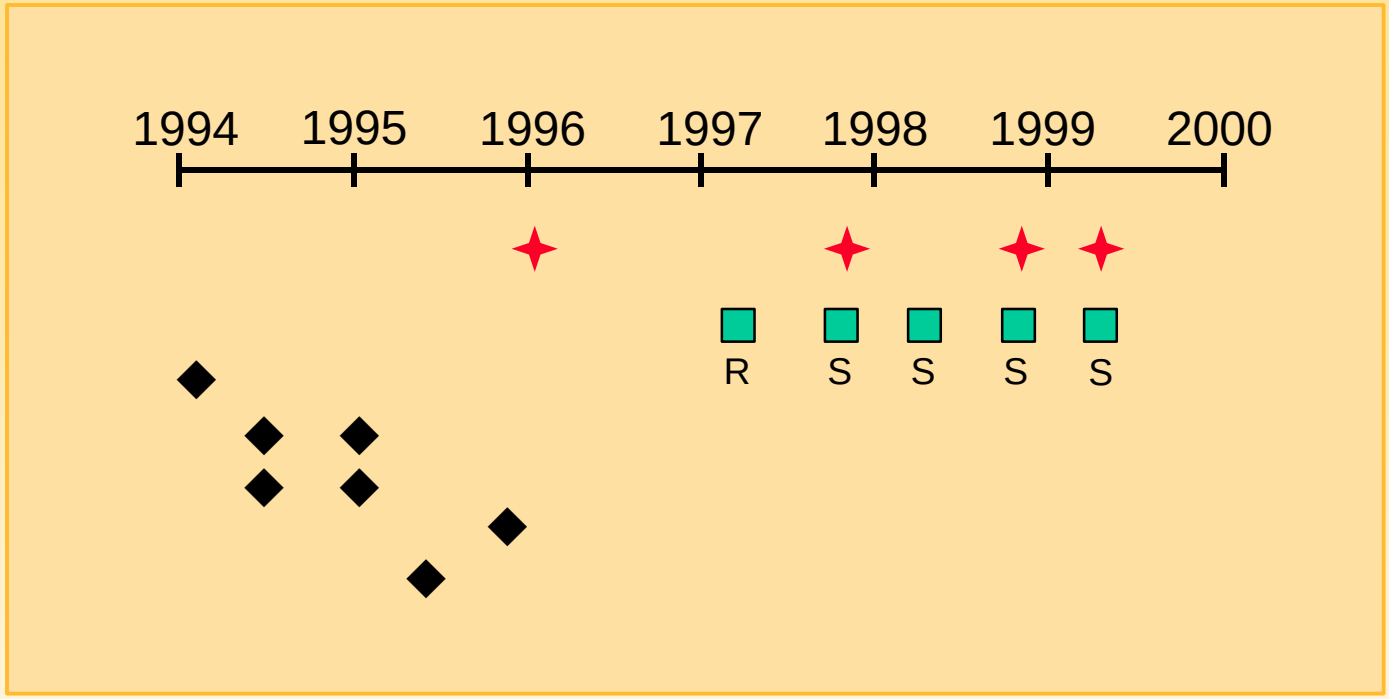
SEAS Center Process Improvement

- 1995 SEAS Process Improvement Plan specified six measurable goals
  - 5 product goals include product quality, productivity, predictability, cycle time, and technology infusion
  - 1 process goal; to attain full compliance with standard industry benchmarks
    - ISO-9001 Registration
    - CMM Level 3 (as determined by independent Software Capability Evaluation (SCE))
- In May 1997, registered to ISO 9001 standard
  In November 1997, assessed as CMM Level 3 and
  In November 1998, assessed as CMM Level 5
  In May 1999, reassessed as sustaining maturity
- Records of investment, changes, approach, and impacts were recorded to benefit CSC organizations and share experiences with professional community

SEAS Center Profile (1997-1998)

- SEAS Center has 850 personnel, primarily working on a NASA contract
  - 300 in software development and maintenance
  - 550 in systems engineering, analysis, and operations
  - Staffing has ranged from 700 to 1700 over past 10 years
- 20 software projects at any one time
- 10-year legacy of process improvement focus
  - First SCE in 1991
  - ISO 9001 registration in 1997

SEAS Center Benchmarking History



- SCE
- ISO 9001 registration audit (R), surveillance audits (S)
- Software process self assessments (SPA) and software process audits

Summary of Benchmarking Activities

	SCE (2/96)	ISO (5/97)	SCE (11/97-1/98)	ISO (11/97)	ISO* (6/98)	SCE (11/98)	Part of 'Group' SCE (5/99)
Preparation time	• 4 months	• 12 months	• 2 months	• 6 months	• 1 month	• 4 months	• 1 month
Organization effort	• 1800 staff hours	• 3400 staff hours	• 800 staff hours	• 500 staff hours	• 200 staff hours	• 800 staff hours	• 60 staff hours
Use of external consultants and training	• None	• 200 hours - Consultant - Internal auditor training - Pre-registration assessment	• None	• None	• None	• 2 staff days	• None
Preparation strategy	• Perform gap analysis • Use lessons learned from 1991 SCE • Focus on deployment	• Develop implementation plan • Use external experts • Train staff • Focus on deployment	• Complete actions items • Provide awareness seminars • Use internal assessments	• Continue process improvement initiatives • Focus on management review, internal audits, and corrective actions	• 1 refresher lecture • Internal audits continued	• Study/learn specific details of level 4-5 • Advance collection of evidence • Group seminars • Mock SCEs	• Update 'evidence' archives • Group seminars
Results	• 13 of 18 KPAs satisfied	• ISO registration achieved	• CMM Level 3 achieved Levels 4-5 (2 of 5 KPAs satisfied)	• ISO registration maintained (2 minor findings)	• ISO registration maintained (3 minor findings)	• CMM Level 5 achieved (18 of 18 KPAs)	• All reviewed KPAs satisfied

* Additional ISO assessments held in 11/98, 5/98, and 11/98

Experiences from the 4 year effort

- What was the cost?
  - Of attaining ‘process maturity’
- What was the ROI?
  - Benefits to business and organization
  - What impact does maturity have on s/w cost, quality, manageability
- Which activities were hardest/ easiest/ most beneficial/ least beneficial?
- What would I tell another organization to do/ not to do?
  - 7 lessons learned

Cost* Distribution for Process

For organization of 800 persons-over 4 years

Activity	4 year cost	1995-1996	1997-1998
Develop/Maintain Processes (write/update)	6 SY	40%	15%
Deploy/Training/Awareness	10 SY	10%	40%
Infrastructure (data base, libraries, distribution)	2 SY	5%	5%
Process Improvement (planning, studies, experiments, analyzing)	8 SY	15%	30%
Assessment Preparation (SCE, ISO)	3 SY	25%	5% - 5%
Reporting/Reviews	1 SY	3%	3%

* Includes cost of developing processes, deploying,measuring, training, maintaining (packaging), developing infrastructure, process improvement; does not include cost of project ops doing CM, QA, Planning, etc.- it does include their cost participating in studies, training, audit participation) Cost based on time: July 1994 through November 1998

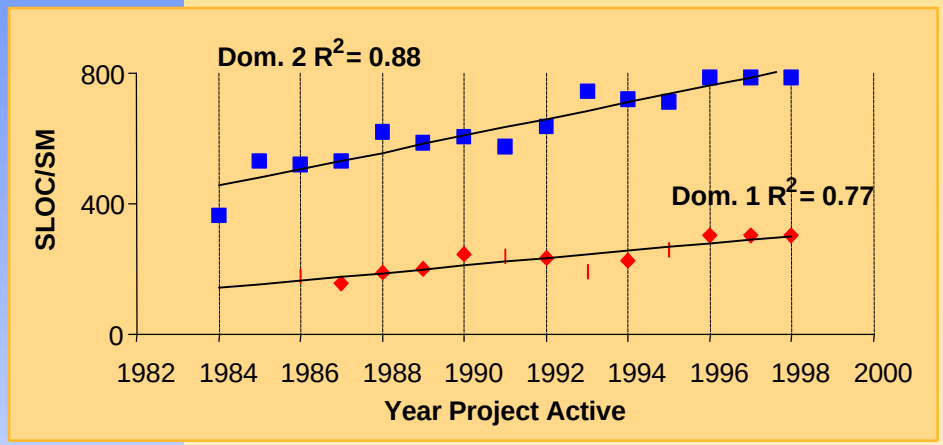
Return on Investment (ROI) from Process Improvement Efforts

- Organizational Value (SEAS) *
  - Drove technology and operational enhancements
    - Increased focus on achieving organizational goals (began operating as an enterprise)
    - Improved communication, teamwork, and understanding and use of organizational processes
    - Provided *discipline* for accelerating improvement programs
    - Resulted in updating of policies and processes to address real needs of organization
    - Accelerated adoption of technology across organization (e.g., electronic document libraries)
    - Fostered pride in achieving one of organizational goals
- Business Value
  - Major contributor to over $500.M new business (first year)
    - 3 major 1998-99 program awards driven by adoption of processes/experiences of SEAS
    - The corporation competitive position has been enhanced in numerous other offerings
    - Provided the first Level 5 Credential for CSC
    - Level 5 proven processes on-line for use by all of CSC

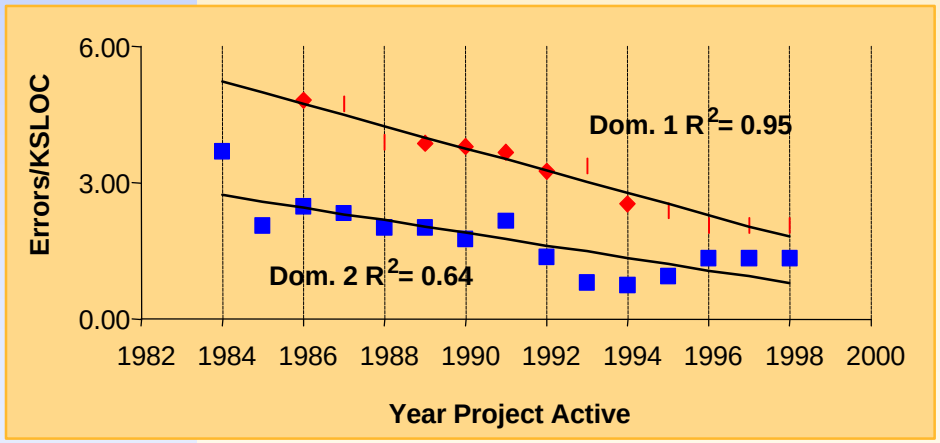
* Based on multiple 'Lessons learned' reports, employee surveys, and assessments by SEAS management staff.

Productivity-Quality Trends Over Time

Average Productivity for all Projects Active in Year



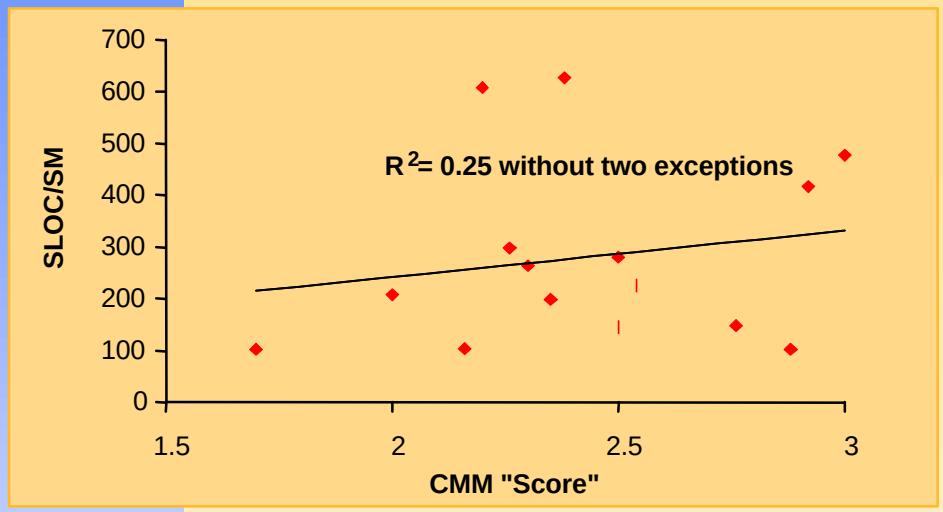
Average Defect Rate for all Projects Active in Year



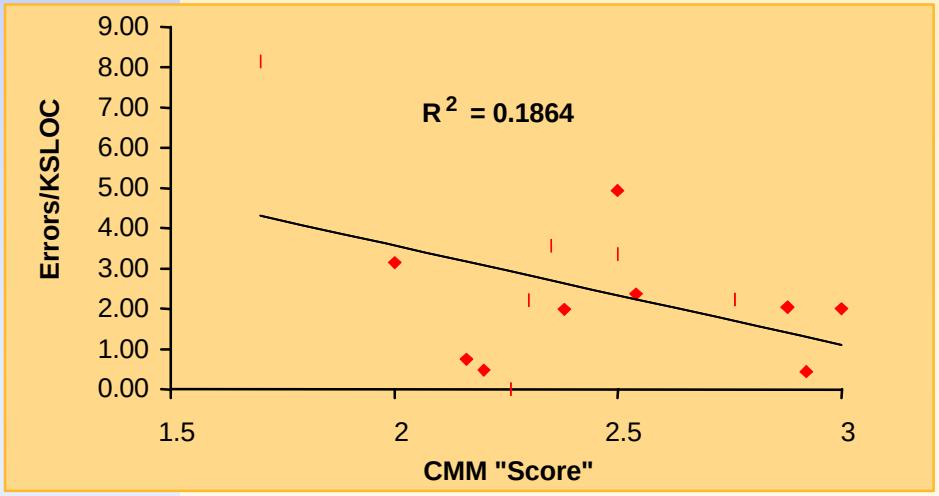
- Consistent/constant 6% per year productivity improvement - even prior to CMM Level 1 rating
- Also 5% per year quality improvement - even prior to CMM Level 1 rating
- No change in improvement rates after aggressive improvement programs started

ROI: Impact of CMM Maturity on Cost, Quality, Manageability

Productivity



Defect Rate



- Detailed measurement data on 90 projects was accumulated (over 9 years).
- Data included accurate product data (cost, defects, size, etc.) and process data (based on assessments).
- Analysis to determine correlation between process maturity and product data showed minimal correlation.

Conclusion: Extremely difficult to measure process impact

X axis determined by number of KPAs satisfied, partially satisfied, not satisfied

Relative Impact of Improvement Activities (Most Significant)

- Shepherding
  - PEO and QA personnel assigned to work directly with projects in guiding process usage and development
  - Project personnel rated this as one of the 2 most helpful assets toward improvement
  - Separation of concerns (SETO vs. SEPG)
- Friday sessions
  - Weekly meetings run by PEO where all managers invited to discuss 'process'- took form of briefings and planning sessions by process/quality staff
  - The weekly process meetings instilled the concepts, goals, asset sharing that had never been attained previously
- Library creation/evidence gathering
  - Activity of producing evidence of processes and assets and capturing in common library provided 2 benefits:
    - Widely shared and actually used
    - Forced the refinement of assets that were '90% complete'
- ISO
  - Goal of only writing what is actually done and limiting the concepts to basics provided significant leverage

Relative Impact of Improvement Activities (Least Significant)

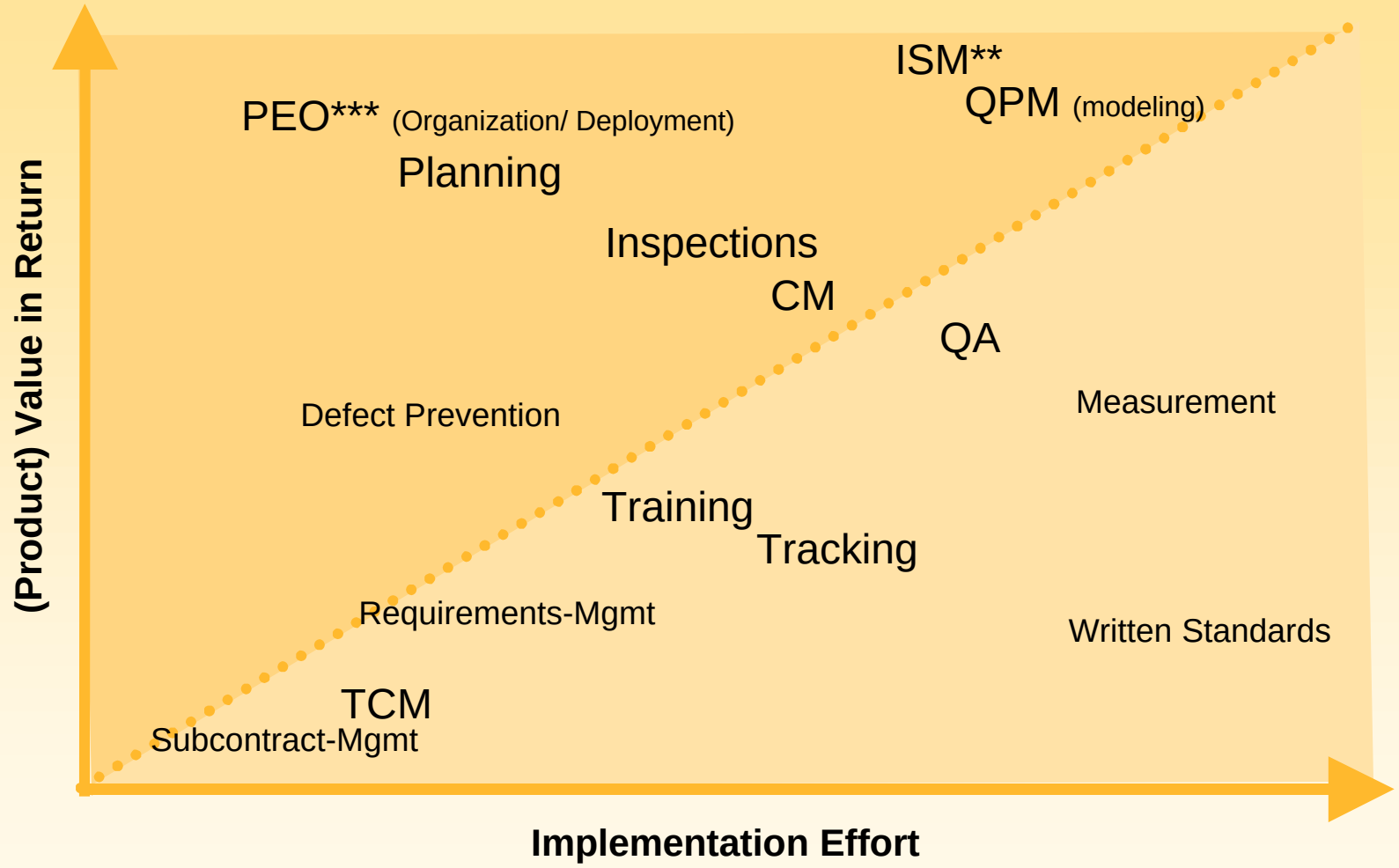
- 'Model driven' measurement
  - Measures collected because they are in model/ as opposed to part of goals. (GQM)
- Compliance matrices/ Gap analysis
  - Exercise of continually mapping perceived weaknesses and strengths to some model matrix required major effort- yet results were rarely used to improve local process
- Writing/ refining/ tailoring standards
  - Nearly 40% of process effort in '94-95 was spent on writing, rewriting standards - as opposed to deploying concepts and approaches to projects. The most used written word can be found in relatively small number of the pages
- Training in CMM, ISO, SA CMM
  - Details of the process rating models are of very limited value to the project staff. The effort we put into training personnel in these models had very limited value. We should have been focusing on the concepts of process and improvement.

ROI* for Process Activities

(Investment is cost of establishing- not operating)

(Return is benefit to projects and organization)

In I Environment- SEAS



*Results based on effort to implement, audit reports, and project evaluations
** ISM includes PAC process and process handbooks
*** PEO includes shepherding, deployment training, PI

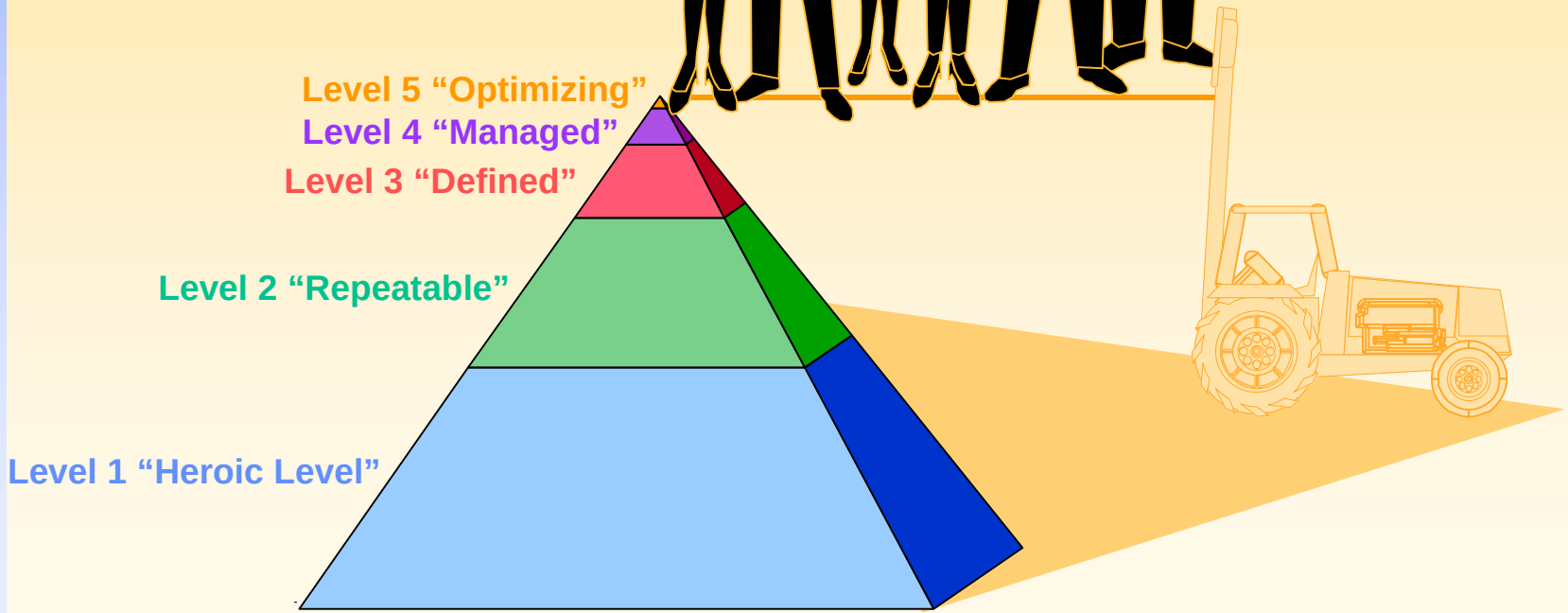
7 Steps to Success

Based on SEAS Process Improvement Experiences

1. Operate as a level 5 at start
2. Set Specific incremental ‘gates’
3. Adopt concept of Separation of Concerns
4. Deploy processes to projects
5. Measure improvement by ‘Product’-
   not by ‘Process’
6. Allocate appropriate resources
7. Produce 3 specific products early

1 Operate As a Level 5 Organization

- Goal is to improve product
- Baseline is process and product understanding
- Many goals drive c
- Change based on
- Measurement is fu
- Emphasis is on tech ca d ties

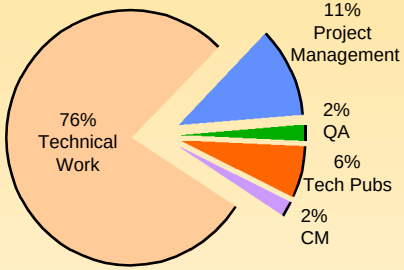


Measure from ‘day 1’; Build models to ‘understand’

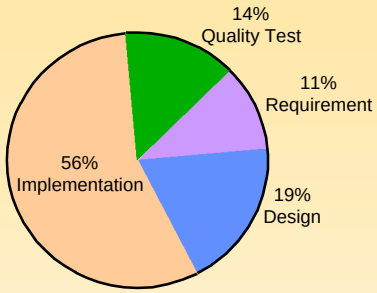
Engineering Models of Processes

NASA Center Software Product Characteristics
(Cost Distribution)

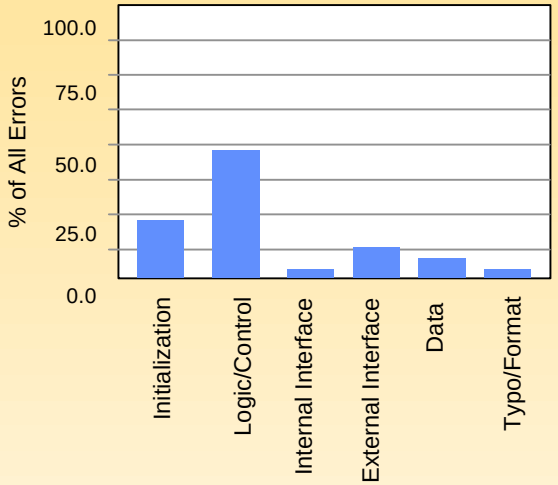
By Support Activity



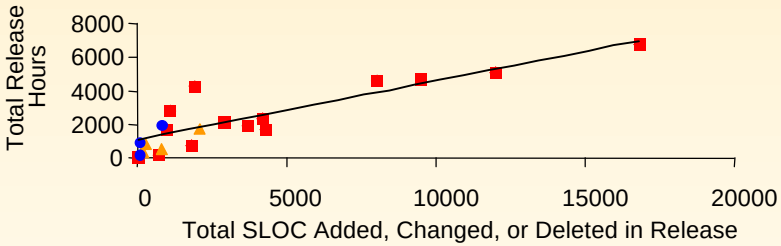
By Development Activity



Defect by Error Class (PCS)



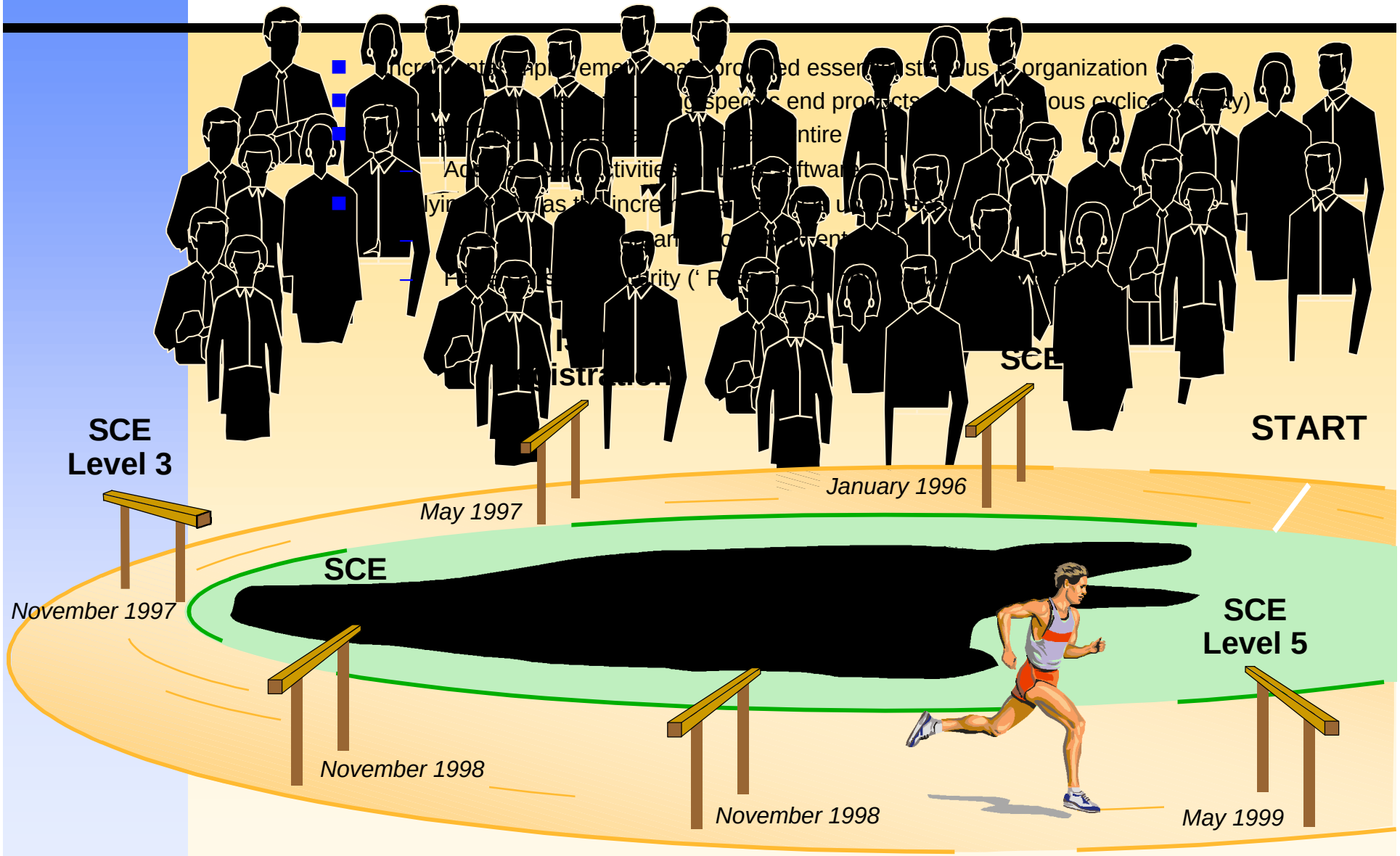
Size of Change Vs. Effort in Maintenance



Effort = (0.36 * SLOC) + 1040 R**2 = .75

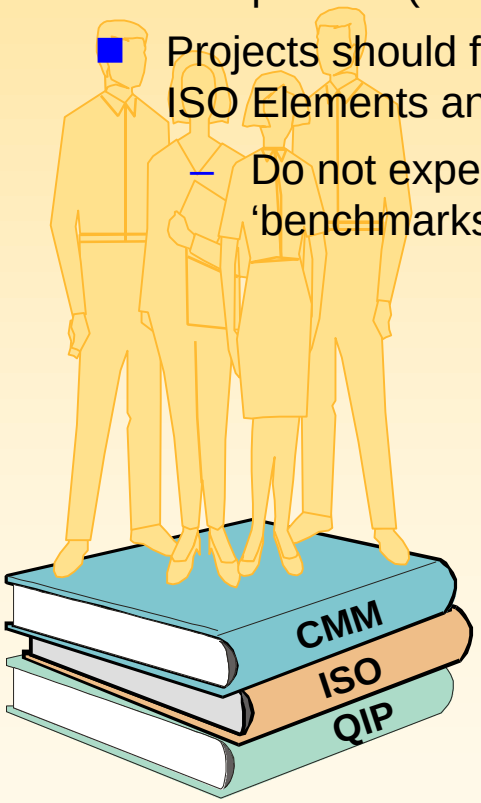
- Enhancement Releases
- Mixed Releases
- Error Correction Releases
- Linear (Enhancement Releases)

2 Set Specific Incremental "Gates"



3 Adopt Concept of Separation of Concerns

- Hide details of benchmark requirements
  - Training must focus on needs of the project, not on detail of CMM, ISO and standards details
- Measure success of projects by ability to produce end-product (not by process expertise)
- Projects should focus on producing good ‘products’, not on learning ISO Elements and CMM KPAs
  - Do not expect or require technical staff to be experts in ‘benchmarks (CMM, ISO, etc.)

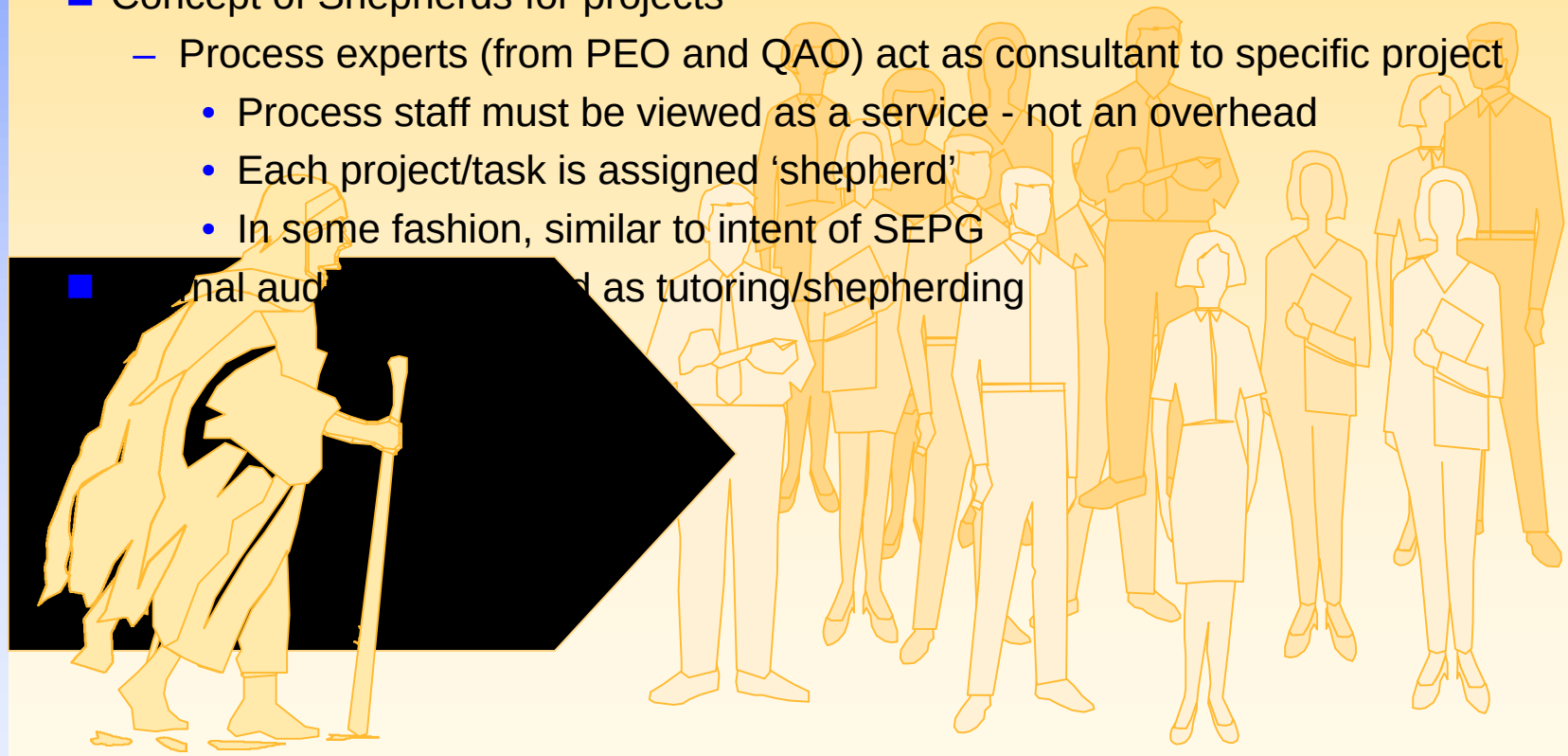


Process Engineers

Software Engineers

4 Deploy Processes to Projects

- Expend 2 to 3 times as much effort in deployment as writing processes
- Friday meetings
  - Combine concepts of ‘tutorials’, sharing (of project experiences) and project status toward reaching some gate (e.g. preparing for SCE, or ISO)
- Concept of Shepherds for projects
  - Process experts (from PEO and QAO) act as consultant to specific project
    - Process staff must be viewed as a service - not an overhead
    - Each project/task is assigned ‘shepherd’
    - In some fashion, similar to intent of SEPG
- [redacted]nal aud[redacted]d as tutoring/shepherding



Process Engineers ***Software Engineers***

5 Measure Improvement by "Product" not by "Process"

Start

- CMM level or benchmark level can provide false sense of accomplishment (or false sense of incompetence)
- CMM and ISO are great tools; they are lousy goals
- Processes should focus on improving your organization; not on complying with benchmark

Finale

6 Allocate Appropriate Resources

*Based on SEAS history**

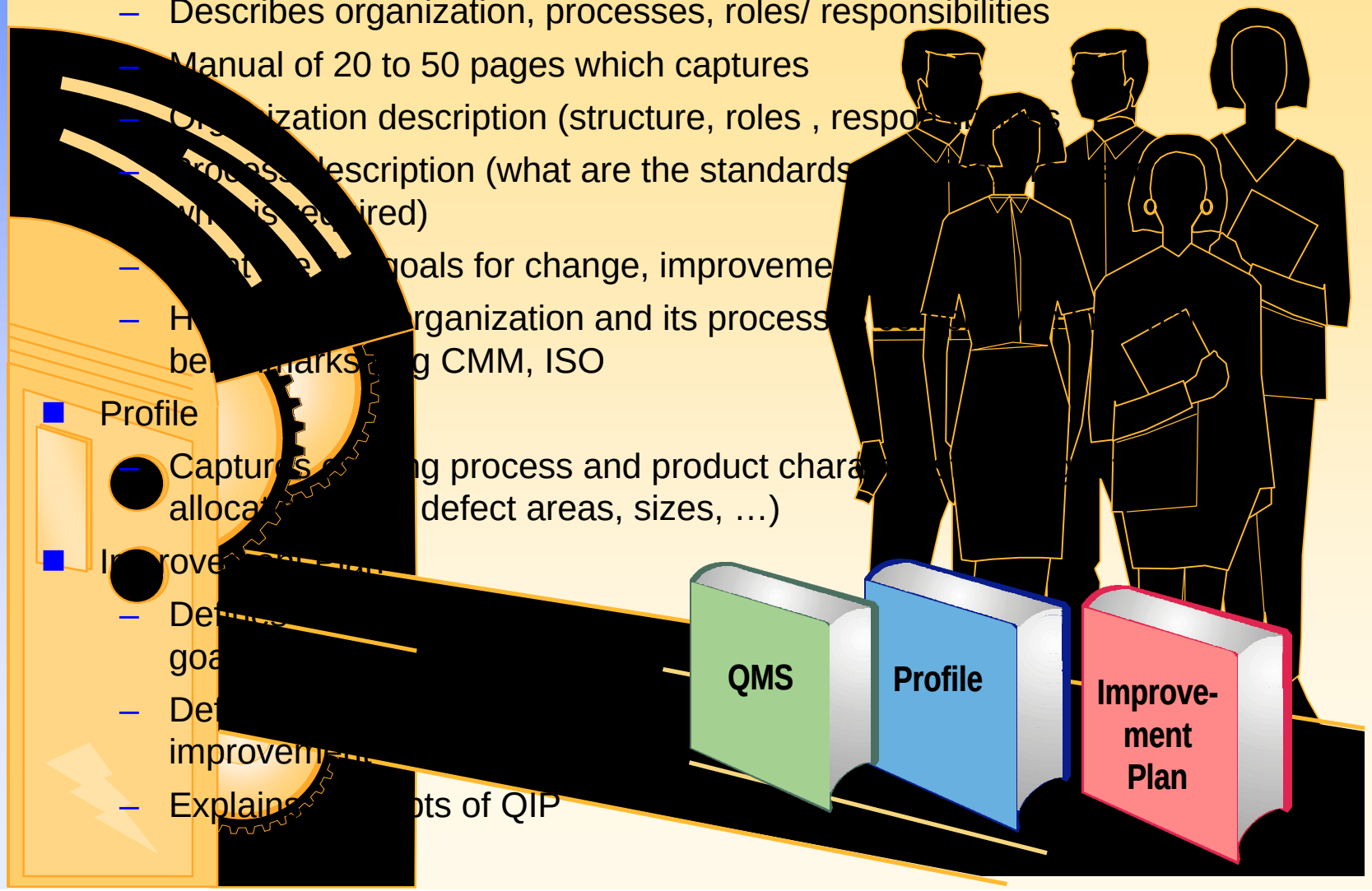
- Requires .8% to 1.3% for process improvement activity
- Quality Assurance requires from 1% to 1.5%
- Spend 2 to 3 times more effort deploying versus writing processes

Program Size	0-20% Software	20-40% Software	40% Up
70 - 150	1.5 FTE	2.0	2.5
150 - 400	2.0 -2.5	2.5 - 4.0	3.0 - 4.5
400 - 900	3.0 - 4.0	3.5 - 4.5	4.5 - 6.0
900 - 1700	3.0 - 5.0	4.0 - 6.0	5.0 - 7.0

**These are identified process personnel for "Program" - (Project support is in addition) (Does not include QAO)*

7 Produce 3 Specific Products Early

- QMS
  - Describes organization, processes, roles/ responsibilities
  - Manual of 20 to 50 pages which captures
  - ization description (structure, roles , respo
  - escription (what are the standards
    ired)
  - oals for change, improveme
  - rganization and its process
    g CMM, ISO
- Profile
  - Captur g process and product chara
    defect areas, sizes, …)
- Improve
  - Def
    goa
  - Def
    improvem
  - Explains ots of QIP



Conclusion

- Process Maturity can be achieved as long as:
  - A structured approach towards the ‘process’ goal is followed
    - Actually the goal is ‘product’ improvement and must be measured as such (success is lower cost, not CMM Level 5)
  - There is a group within the organization that shepherds the improvement process
    - Senior, competent personnel
  - Focus remains on process improvement (vs. “just meeting the benchmark”)
  - Latitude is provided to support ‘cultural change’ for overall organization
  - There is management sponsorship and commitment (Resources, participation, ‘patience’)